Heavy-Duty Diesel Fuel Analysis Program

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California Environmental Protection Agency

Air Resources Board

Heavy-Duty Diesel Fuel Analysis Program

- The EPA's heavy-duty diesel fuel analysis program seeks to quantify the air pollution emission effects of diesel fuel parameters on various non-road and highway heavy-duty diesel engines.
- The program examines the HC, NOx, and PM emission impacts of diesel fuel parameters including, but not limited to, parameters as cetane number, aromatics content, and fuel density.

Heavy-Duty Diesel Fuel Analysis Program

- The Air Resources Board appreciates the opportunity to review and provide input to Heavy-duty Diesel Fuel Analysis Program.
- The Air Resources Board supports the use of cleaner fuels as a strategy to achieve emission reductions.

California Diesel Fuel Program

- Adopted in 1988.
- Implemented October 1993.
- Adopted regulations for sulfur and aromatics.
- The regulations allow fuel producers to develop an alternative diesel formulation if they demonstrate that their alternative diesel formulation would produce the same or lower emissions than the 10% aromatic reference fuel.
- Almost all refiners have taken advantage of this provision to lower their diesel fuel production costs.

Comparison of Current Federal and California Diesel Specifications

Property	*California*	*Federal*
Sulfur	500 ppm	500 ppm
Aromatic Hydrocarbons		
Large Refiners	10 Vol. %	---
Small Refiners	20 Vol. %	---

- Applicability
  - California: on- and off-road vehicles
  - Federal: on-road vehicles only

California Diesel Program Benefits[a] (tons/day)

Pollutant	Federal	California
SO_2	60	80 (80%)
PM (Directly Emitted)	4	20[b] (25%)
NO_X	0	70 (7%)

[a] **Calculated for 1995 Inventory**

[b] **Includes hazardous pollutant benefits from reduced PM.**

Average Specifications of Reformulated Diesel Fuel

Specification	California Pre-1993	California 1999	U.S.[1] 1999
Aromatics, vol%	35	22	35
Sulfur, ppmw	440[2]	110[3]	360
Cetane No.	43	52	45
PNA	---	3	---
Nitrogen	---	150	110

1. AAMA National Fuel Surveys
2. For Los Angeles area (Greater than 3000 ppm in rest of California)
3. About 10 % of total California volume is < 15 ppmw

Heavy-Duty Diesel Fuel Analysis Program

- Assembled a large and useful database.
- Model emissions response as a Mixed Effects Linear Model.
- Percent change should be used.
- Southwest Research Institute Report is well written and clear.

Mixed Effects Models

Terms	Effects	Source of Variation
Fuel Properties	Fixed	Low
Engines	Random	High
Fuel Properties by Engine	Random	High to Medium

Heavy-Duty Diesel Fuel Analysis Program

- Concerns include:
  - No natural cetane effect.
  - How to model technology by fuel parameter terms with only a few observations.
  - How to weight individual technology groups.
  - How to limit over fit - Information Criteria or Cross-Validation.
  - Stakeholder review of the dataset.
  - Lack of a validation data set.

Heavy-Duty Diesel Fuel Analysis Program

- Many different models can be developed with about the same fit.
  - Model should not be overly complicated.
  - Model should be usable.
  - Model should be compared to other models.
  - Model should be validated.
  - Uncertainty estimates should be included

Heavy-Duty Diesel Fuel Analysis Program

- While Texas has adopted the California Diesel Program, California refineries are different than Texas refineries (CaRFG2, CaRFG3, CNG, etc.).
- Some important fuel properties, that play a significant role in the modeling, are not controlled under the Texas regulations.
- Almost all diesel produced in California is consumed in California.
- Benefits may not be the same as for California, such as different baselines.

Heavy-Duty Diesel Fuel Analysis Program

- ARB staff supports the U.S. EPA efforts to develop a useful model.
- The ARB staff appreciates the opportunity to comment and provide input.